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The relationship between Integrated Logistics Support (ILS) and Computer-aided Acquisition and Logistics Support (CALS)

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THE RELATIONSHIP BETWEEN INTEGRATED LOGISTICS SUPPORT (ILS) AND COMPUTER-AIDED ACQUISITION AND LOGISTICS SUPPORT (CALS)

by

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Integrated Logistics Support (ILS) is the disciplined and unified management of the technical logistics disciplines that plan and develop support for military forces. With the implementation of the ILS concept, there has been a remarkable progress; yet substantial problems were found that had to be addressed. In an effort to tackle such problems in the acquisition of weapon systems and logistics support, the United States Department of Defense formulated a new concept. Computer-aided Acquisition and Logistics Support (CALS) is an initiative to enable and accelerate the integration of digital information for major system acquisition, design, manufacture, and support. This thesis examines the relationship between Integrated Logisitcs Support (ILS) and Computer-aided Acquisition and Logistics Support (CALS) and proposes the better way of understanding of ILS and CALS concept for the future Korean Armed Forces Logistics Support and Acquisition.

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ABSTRACT

Integrated Logistics Support (ILS) is the disciplined and unified management of the technical logistics disciplines that plan and develop support for military forces. With the implementation of the ILS concept, there has been a remarkable progress; yet substantial problems were found that had to be addressed. In an effort to tackle such problems in the acquisition of weapon systems and logistics support, the United States Department of Defense formulated a new concept. Computer-aided Acquisition and Logistics Support (CALS) is an initiative to enable and accelerate the integration of digital information for major system acquisition, design, manufacture, and support. This thesis examines the relationship between Integrated Logistics Support (ILS) and Computer-aided Acquisition and Logistics Support (CALS) and proposes the better way of understanding of ILS and CALS concept for the future Korean Armed Forces Logistics Support and Acquisition.

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LIST OF ABBREVIATIONS

ADP	Automated Data Processing
ALPS	Automated Logistics Publishing System
AMC	Army Material Command
AMIS	Automation Maintenance Information System
AMS	Automated Maintenance System
ANSI	American National Standards Institute, Inc.
APDE	Application Protocol Development Environment
AR	Army Regulation
CAD	Computer-aided Design
CAE	Computer-aided Engineering
CALS	1. Computer-aided Acquisition and Logistics Support 2. Continuous Acquisition and Life Cycle Support
CAM	Computer-aided Manufacturing
CCITT	Consultative Committee on International Telegraphy and Telephony
CDSO	CALS Digital Standards Office
CE	Concurrent Engineering
CGM	Computer Graphics Metafile
CIM	1. Computer Integrated Manufacturing 2. Corporate Information Management
CITIS	Computer Integrated Technical Information Service
CTN	CALS Test Network
DARMIS	Data Requirements Management Information System
DDN	Defense Data Network
DEMVAL	Demonstration and Validation
DIS	Draft International Standards
DISA	Defense Information Systems Agency
DLA	Defense Logistics Agency
DLSC	Defense Logistics Service Center
DLSS	Defense Logistics Standard Systems
DOD	Department of Defense
DSREDS	Digital Storage and Retrieval of Engineering Data System (ARMY)

ED	Engineering Drawing
EDCARS	Engineering Drawing Computer-aided Retrieval System (AIR FORCE)
EDI	Electronic Data Interchange
EDMICS	Engineering Data Management Information Control System (NAVY)
EDS	Electronic Display System
FSD	Full-Scale Development
GDP	Gross Domestic Product
GOSIP	Government Open Systems Interconnect Protocol
IDIS	Institute for Defense Information Systems
IETM	Interactive Electronic Technical Manual
IGES	Initial Graphics Exchange Specification
ILS	Integrated Logistics Support
ISA	Information Systems Architecture
ISDN	Integrated Services Digital Network
ISG	Industry Steering Group
ISO	International Standards Organization
IWSDB	Integrated Weapon Systems Data Base
JCALS	Joint Computer-aided Acquisition and Logistics Support
JEDMICS	Joint Engineering Data Management Information and Control System
JLSC	Joint Logistic Systems Center
JSLSA-TWG	Joint Service LSA Technical Working Group
KAF	Korean Armed Forces
LAN	Local Area Network
LCC	Life Cycle Cost
LSA	Logistics Support Analysis
LSAR	Logistics Support Analysis Record
MND	Ministry of National Defense of South Korea
NIST	National Institute of Standard and Technology
NSIA	National Security Industrial Association
OSD	Office of the Secretary of Defense
PDES	Product Data Exchange Using STEP
R&D	Research and Development

RFP	Request for Proposal
SGML	Standard Generalized Markup Language
STEP	Standard for the Exchange of Product Model Data
TDI	Technical Data Interchange
TDSS	Technical Data Storage System
TIMS	Technical Information Management System
TM	Technical Manual
TMDE	Test Measurement and Diagnostic Equipment
WAN	Wide Area Network

I. INTRODUCTION

A. GENERAL

Effective acquisition and logistics support of weapon systems has long been an issue for those who were interested in the effective use of a limited budget. In 1964, recognizing the increasing need for more effective maintenance support measures, the United States Department of Defense directed that the basic element of Integrated Logistics Support (ILS) be included in planning for acquisition of defense systems and major items of equipment [Ref. 1:p. 56]. Blanchard said Integrated Logistics Support (ILS) is basically a management function that provides the initial planning, funding, and controls that help assure that the ultimate consumer (or user) will receive a system that will not only meet performance requirement, but one that can be expeditiously and economically supported throughout its programmed life cycle [Ref. 2:p. 13]. With the implementation of the ILS concept, there has been a remarkable progress; yet substantial problems were found that had to be addressed.

In an effort to tackle such problems in the acquisition of weapon systems and logistics support, the United States Department of Defense formulated a new concept. Computer-aided Acquisition and Logistics Support (CALS) is an initiative to enable and accelerate the integration of digital information for major system acquisition, design, manufacture, and support. Under the authority of the Under Secretary of Defense for Acquisition, the CALS initiative is being used to improve the information infrastructure that supports acquisition and logistics.

Recently the Ministry of National Defense (MND) of Korea has recognized the relevance and significance of these concepts for its operation. The Ministry of National Defense (MND) of Korea is confronted with budget constraints. Even though the absolute amount of the defense budget is increasing, the increase rate is below the average growth rate of the GDP. So now the Ministry of Defense of Korea is experiencing relative budget reduction. Table 1 shows the decline in defense spending in South Korea. From the Ministry of Defense of Korea's White Paper, currently the defense budget accounts for less than 4% of GDP and approximately 24% of the government budget. The 65% of

the defense budget is for operation and maintenance and, within this operation and maintenance budget, 45% is allocated for logistics support [Ref. 7].

(%)

FISCAL YEAR	1988	1989	1990	1991	1992	1993
DEFENSE SPENDING / GDP	5.4	5	4.4	4.0	3.6	3.5
DEFENSE SPENDING / GOVERNMENT BUDGET	32.8	32.4	30.4	27.6	25.1	24.2

Table 1. South Korea Defense Spending against GDP and Government Budget

Under this situation, effective and efficient use of money is required. To reduce cost and response time and to increase operational availability, it is very important to consider Integrated Logistics Support (ILS) and Computer-Aided Acquisition and Logistics Support (CALS) concepts.

B. PURPOSE AND SCOPE

The objective of this thesis research is to examine the relationship between Integrated Logistics Support (ILS) and Computer Aided Acquisition and Logistics Support(CALS) and to determine how ILS can be improved by adding CALS. Chapter II talks about the background and problems of ILS and discusses the importance of logistics support, the concept of modern military logistics, and the elements of ILS. Chapter III focuses on objectives, environment, and method for implementing CALS. Chapter IV addresses how ILS and CALS can complement each other to achieve the ultimate effectiveness of acquisition and logistics support processes. Chapter V presents conclusions.

II. INTEGRATED LOGISTICS SUPPORT(ILS)

A. BACKGROUND

1. Objectives of ILS

The recent economic trend characterized by rising inflation, cost growth, continuing reduction in buying power, budget limitations, increased competition, and so on, has created an awareness and interest in total system and product cost. Not only are the acquisition costs associated with new systems rising, but the costs of operating and maintaining systems already in use are increasing at alarming rates. In essence, many of the systems and products in existence today are not truly cost effective [Ref. 2:p. 71].

A major Integrated Logistics Support (ILS) objective is to assure the integration of the various elements of support. More precisely, the Department of Defense (DoD) defines ILS as a disciplined, unified, and iterative approach to the management and technical activities necessary to accomplish the following goals:

a. to integrate support considerations into system and equipment design;
b. to develop support requirements that are related consistently to readiness objectives, to design, and to each other;
c. to acquire the required support; and
d. to provide the required support during the operational phase at minimum cost [Ref. 2:p. 13].

Under ILS, logistics analyses are conducted to identify ways that a design can be changed to improve support or supportability as well as to identify the resources that will be required to support the system when it is used.

2. Phases of ILS

Actually there are two phases in the ILS. Phase I is everything that is done to plan and acquire support before a system is delivered to the user. Phase II includes the things that are done to support the equipment while it is being used.

Phase I occurs during the design and production of a system, and its duration might be only a few years. Phase II, the useful life of a system, can last up to 20 or 30 years. The important thing to remember is that the actions that occur during Phase I dictate how well the system will be supported during Phase II [Ref. 3:p. 5].

B. ILS ELEMENTS AND LIFE-CYCLE

1. ILS Elements

Logistics is the science of planning and implementing the acquisition and use of resources necessary to sustain the operation of military forces. Integrated Logistics Support (ILS) is the disciplined and unified management of the technical logistics disciplines that plan and develop support for military forces. In general, this means that ILS is the management organization that plans and directs the activities of many technical disciplines associated with the identification and development of logistics support requirements for military systems [Ref. 3:p. 1]. Allen says that ILS is an integral part of all aspects of system planning, design and development, test and evaluation, production and/or construction, consumer use, and system retirement. The elements of support must be developed on an integrated basis with all other segments of the system [Ref. 4:p. 11]. The principal elements of ILS are maintenance planning, reliability and maintainability, technical data, personnel and training, facilities, support and test equipment, supply support, packaging, transportation and handling, logistics support resource funds, and logistics management information.

a. Maintenance Planning

Maintenance planning establishes concepts and requirements for each level of equipment maintenance to be performed during its useful life. As such, maintenance planning defines the actions and supporting requirements necessary to maintain the designed system and equipment in its prescribed state of operations. The maintenance plan responds first to readiness requirements and next to economies in the commitment of supporting resources.

b. Reliability and Maintainability

The area of reliability and maintainability addresses how long a system will operate without failure and how long it will take to fix an item when it fails. Both maintainability and reliability are included as maintenance preventive characteristics in equipment design and support resources requirements. Maintainability and reliability goals must be integrated into the equipment and support system design through requirement and contract specifications.

c. Technical Data

The purpose of the technical data program is to provide for the timely development and distribution of technical data necessary to conduct operations, training maintenance, supply, modification, repair and overhaul of the systems and equipment. Technical data provides the link between personnel and equipment. It includes special purpose computer programs and other forms of audio and visual presentation required to guide people performing operations and support tasks.

d. Personnel and Training

A realistic estimate of current manning capabilities, in terms of both numbers and skills, must be made against the probable quantitative and qualitative manning demands of the system or equipment concepts under study. Personnel and training planners must progressively identify manning requirements for test and demonstration, operation and maintenance in the user environment. They must consider task categories and resulting optimum skill mixes needed to achieve or exceed readiness performance goals. Personnel requirements for operations and maintenance must be balanced against manpower availability.

e. Facilities

The purpose of the facilities program is to assure that all required facilities are available to the operating forces and supporting activities in a timely manner. The ability to perform the mission could depend on the adequacy of facilities provided concurrently with the prime system or equipment. Facilities planning requires support management attention through all phases of the life cycle to provide positive coordination with other program elements.

f. Support and Test Equipment

The purpose of the support and test equipment program is to assure that the required support and test equipment is available to the operating forces and supporting maintenance activities in a timely manner. The ability to perform the required unscheduled and scheduled maintenance depends on the adequacy of the support and test equipment identified or developed concurrently with the prime system and equipment.

g. Supply Support

Maintaining operational readiness under diverse conditions of military use depends directly on the availability of the right supplies at the time and place they are needed. Supply support is an essential element of the logistics integration effort and responsible for the timely provisioning, distribution and inventory replenishment of spares, repair parts, and special supplies.

h. Packaging, Transportation and Handling

The transportation and handling element includes the characteristics, actions and requirements necessary to insure the capability to transport, preserve, package and handle all equipment and support items. The functional requirements and actions are developed from operations and maintenance analyses, equipment design drawings, specifications and other documentation defining transportability criteria, handling equipment and procedures, and packaging and preservation needs.

i. Funding

Successful ILS planning during all phases of the equipment life cycle requires management attention to the interface between the support element needs and defense budgeting and financing procedures. Because of their importance to implementing logistics support, budgeting and financing activities are included as a prime element of support management.

j. Management Data

Early in the development phase of the acquisition life cycle, Support Management selectively identifies the extent to which the information systems will

be required during the item's life cycle, when they will be required and how and by whom the requirements will be met. Data become useful information only when they are assembled into manageable aggregates for purposeful evaluation. When this can be easily done manually, time and costs can be reduced. When sampling or summary techniques can provide needed information on a one-time or periodic basis, redundant report processing is eliminated [Ref. 5].

2. Establishment of the Modern Military Logistics Support

The U.S. Army Regulation (AR) on integrated logistics support explains that the ILS affects overall system readiness, supportability, and affordability. The cost of acquiring the right logistics support at the right time has never been well understood. These costs are now receiving serious attention as weapon systems development and operation become significantly more expensive. Life Cycle Cost (LCC) affordability issues are gaining importance and may become the baseline consideration on whether a system in development will continue or will be canceled. From a material development and fielding standpoint, the Vietnam experience had an unexpected influence on the U.S. Army's material system. While the U.S. Army's focus was on Vietnam from 1965 to about 1972, weapon systems were in Research and Development (R&D) but rarely moved to production and development.

By early 1970s, the U.S. Army was poised at the beginning of the most exciting modernization effort it had ever experienced. The concept of integrating the various logistics functions emerged and integrated logistics support was born. During mid-to late- 70s, two additional conditions complicated logistics planning and acquisition. First major consideration was that along with increasing technical complication, the U.S. Army began to cross commodity boundaries by mixing various items into a single "weapon systems". The second, weapon systems were rapidly becoming more technically complicated. This resulted in more expanded definitions of ILS elements including support equipment; Test, Measurement, and Diagnostic Equipment (TMDE); and computer resources requirements. The overall goal of ILS management is to introduce and sustain fully supportable material systems in current and projected environments that meet established operational and System Readiness Objectives (SRO) at minimum LCC [Ref.6:p.31].

3. Life-cycle Cost

Logistics support is a significant contributor to life cycle cost. Furthermore, the decisions made during early stages of system planning and conceptual designs have a serious impact on the projected life cycle cost for a given system. It is therefore essential that logistics support be considered, as part of the decision making process, in the early stages of weapon system planning and design. When we address total cost, we must consider not only visible system acquisition cost but also other costs as well. The cost visibility problem can be related to the "iceberg effect" illustrated in Figure 1. [Ref. 2: p. 71]

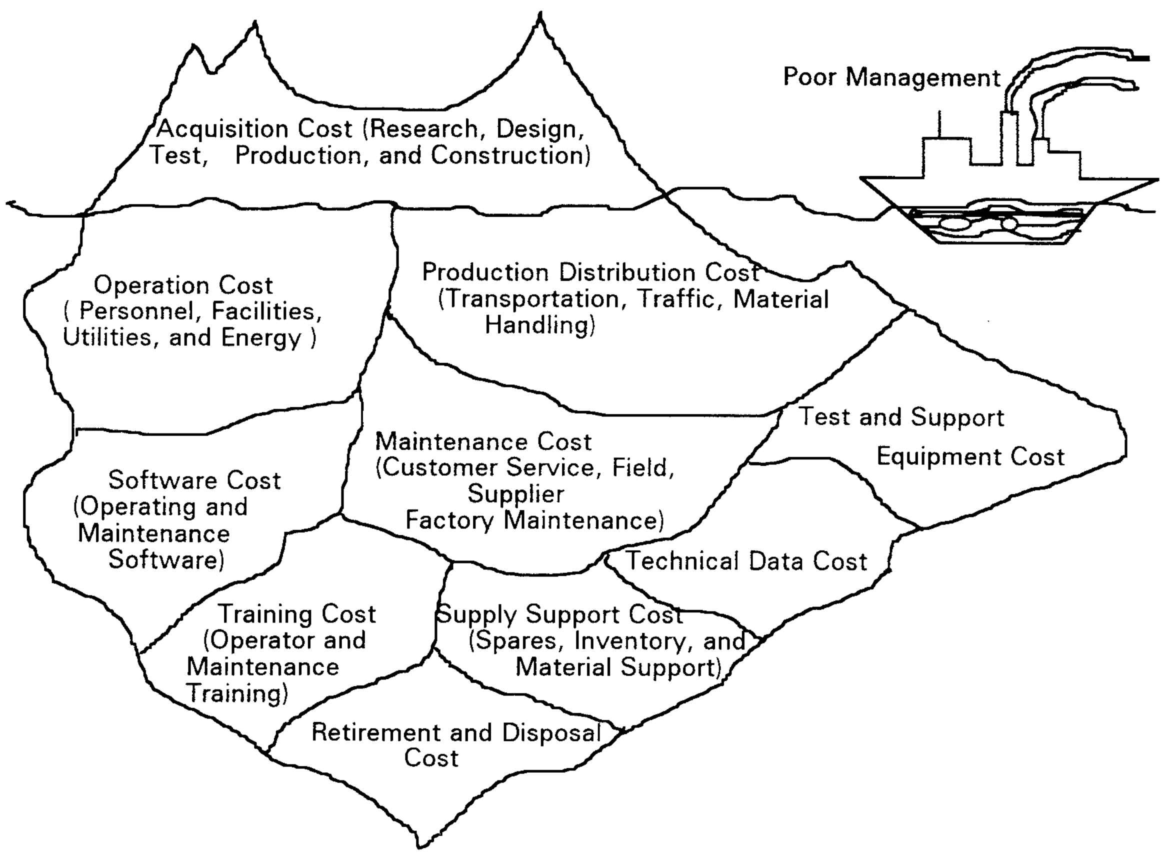

Figure 1. Total Cost Visibility [Ref. 2: p. 71]

In developing cost data, the main step is to define the system life cycle, and to project the various activities applicable for each phase. The life cycle cost includes the cost associated with all system activities pertaining to research and development, design, test and evaluation, production, construction, product distribution, system operation, sustaining maintenance and logistics support, and system retirement and disposal. Individual cost factors, estimated for each year in the life cycle in terms of the actual anticipated cost for that year, are totaled and projected in the context of a profile illustrated in Figure 2 and Figure 3. This profile reflects future life cycle budgetary requirements for the system. Figure 2 illustrates individual cost factors. Figure 3 represents a system cost profile showing yearly separate cost factors [Ref. 2:p. 77].

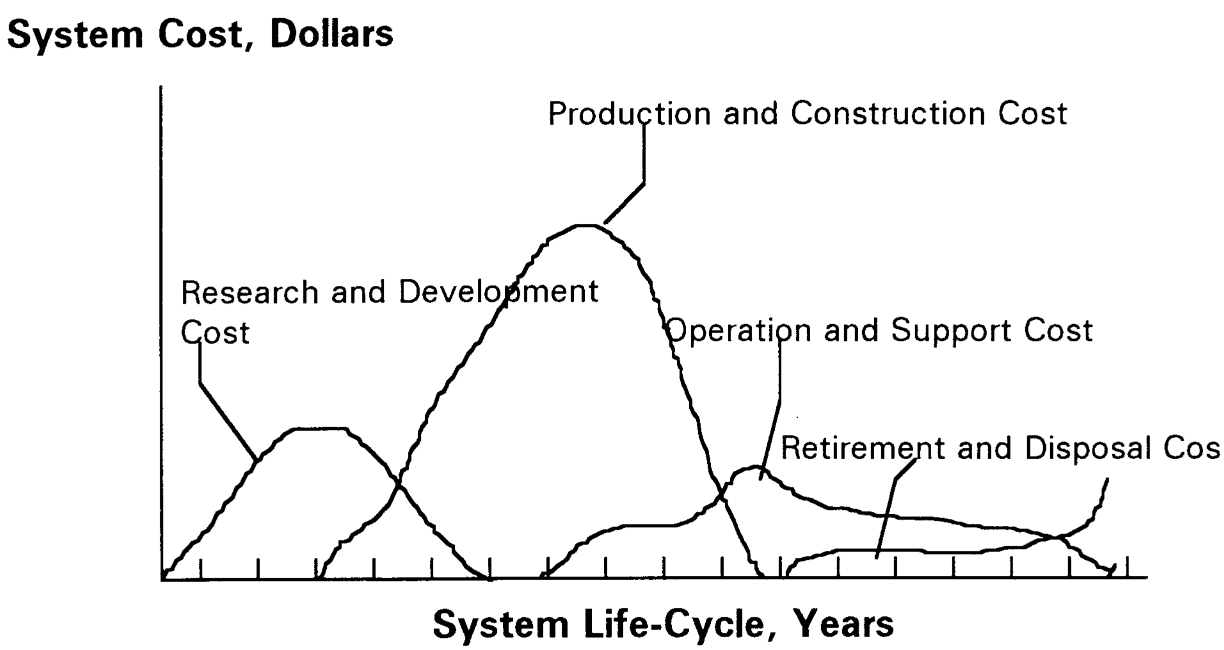

Figure 2. Individual Cost Factors in a System Life-Cycle [Ref. 2: p. 77]

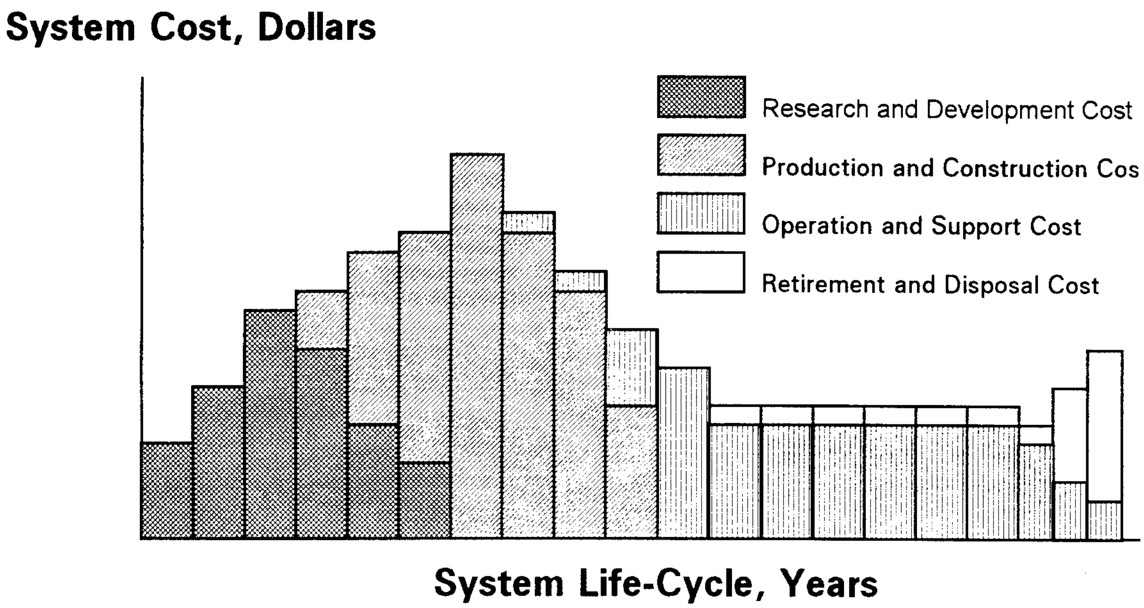

Figure 3. System Cost Profile [Ref. 2: p.77]

4. Acquisition Cycle

ILS begins with the acquisition planning for an item of equipment and continues throughout its useful life. This evolutionary process is the same for all items, whether a small piece of equipment or a major weapon system. The acquisition cycle is divided into seven distinctly different phases, and ILS is involved in each phase [Ref. 3:p. 11]. Normally these are preconcept, concept, demonstration and validation, full-scale development, production, deployment and operation, and disposal. Each phase has a definite start and end, although there might be overlap between phases. Figure 4 illustrates the phases of the acquisition cycle.

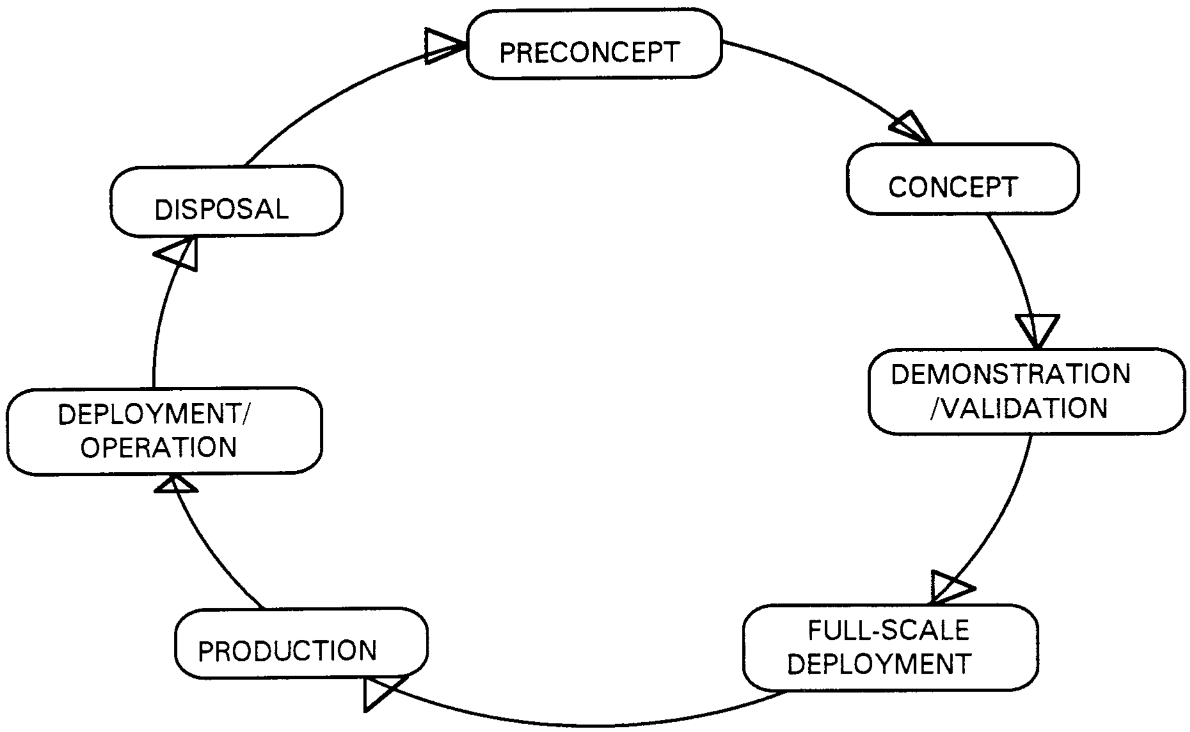

Figure 4. Acquisition Cycle [Ref. 3: p. 12]

a. Preconcept Phase

The purpose of the preconcept phase is to fully define the new need, develop a complete mission profile for the new equipment, identify in gross terms the resources that exist or must be developed to fulfill the need, and establish priorities for continuing the acquisition process.

b. Concept Phase

During the concept phase, all possible approaches to fulfilling the need are identified. The positive attributes and risks involved with each alternative are evaluated to ensure that the alternatives selected are capable of fulfilling the need. The result of the concept phase is selection of the most feasible alternative,

or alternatives, for further study. If an alternative cannot be identified, then the cycle reverts to the preconcept phase for redefinition of the need.

c. *Demonstration and Validation Phase*

The purpose of the Demonstration and Validation phase(DEMVAL) is two-fold:

(1) to transform the concept into a functioning item and demonstrate that it actually works, and

(2) to validate that the item will fulfill the need defined during the preconcept phase.

Failure of all alternatives to pass DEMVAL returns the process to the concept phase for identification of more alternatives.

d. *Full-Scale Development Phase*

During FSD the proposed equipment undergoes a complete engineering process to develop an equipment design that meets all the requirements of the need and that will perform in the field. The purpose of FSD is to produce an equipment design that is reliable, maintainable, producible, and supportable. A large percentage of ILS activity occurs during FSD.

e. *Production Phase*

Actual manufacturing of new equipment occurs during the production phase. This is the first appearance of the complete, operational equipment. The design of the equipment is frozen at the start of production and cannot be changed thereafter without formal approval of the government.

f. *Deployment and Operation Phase*

After the equipment is manufactured, the government assumes ownership and the deployment and operation phase begins. The equipment is fielded and starts fulfilling the need identified during the preconcept phase. As the equipment functions in its intended environment, its capability to fulfill the need is continually evaluated. The equipment's performance is also evaluated as needs arise.

g. *Disposal Phase*

When a new item of equipment is fielded, the item being replaced is phased out and the disposal phase begins for the old item. This phase continues until all of the old equipment is purged from the government inventory or redistributed to fulfill other needs. As stated above, the acquisition cycle is a never ending circle of events that continually addresses new needs as they are identified [Ref. 3: p. 13].

5. Life-cycle Process

Logistics becomes a major consideration in early system design and development. Initially, logistics must be a factor in the assessment of need and in the feasibility analysis. System operational requirements are defined which lead to the definition of a maintenance concept. The design process then evolves through the definition of design criteria, the functional analysis and allocation of criteria, synthesis and optimization, test and evaluation, and so on [Ref. 2:p. 94]. The life cycle process, illustrating the interfaces between system activities and major logistics functions, is shown in Figure 5.

C. DEVELOPMENT PROCESS

After the birth of the concept of Integrated Logistics Support (ILS), military logistics has been much developing in many ways. Since 1973, the Logistics Support Analysis (LSA) process has served as the keystone of Integrated Logistics Support (ILS). The concept of the LSA process was originally set forth in October 1973 with the first publication of MIL-STD-1388-1 and MIL-STD-1388-2.

Crabtree and Atkinson pronounce that the LSA process has been and continues to be an orderly, cost-effective approach to conducting those activities necessary to integrate supportability in system design; determine required support; and prepare ILS/LSA data products. In November 1978, after five years of experience with the LSA process, DoD tried to share experiences and increase cooperation in the implementation and standardization of the LSA process.

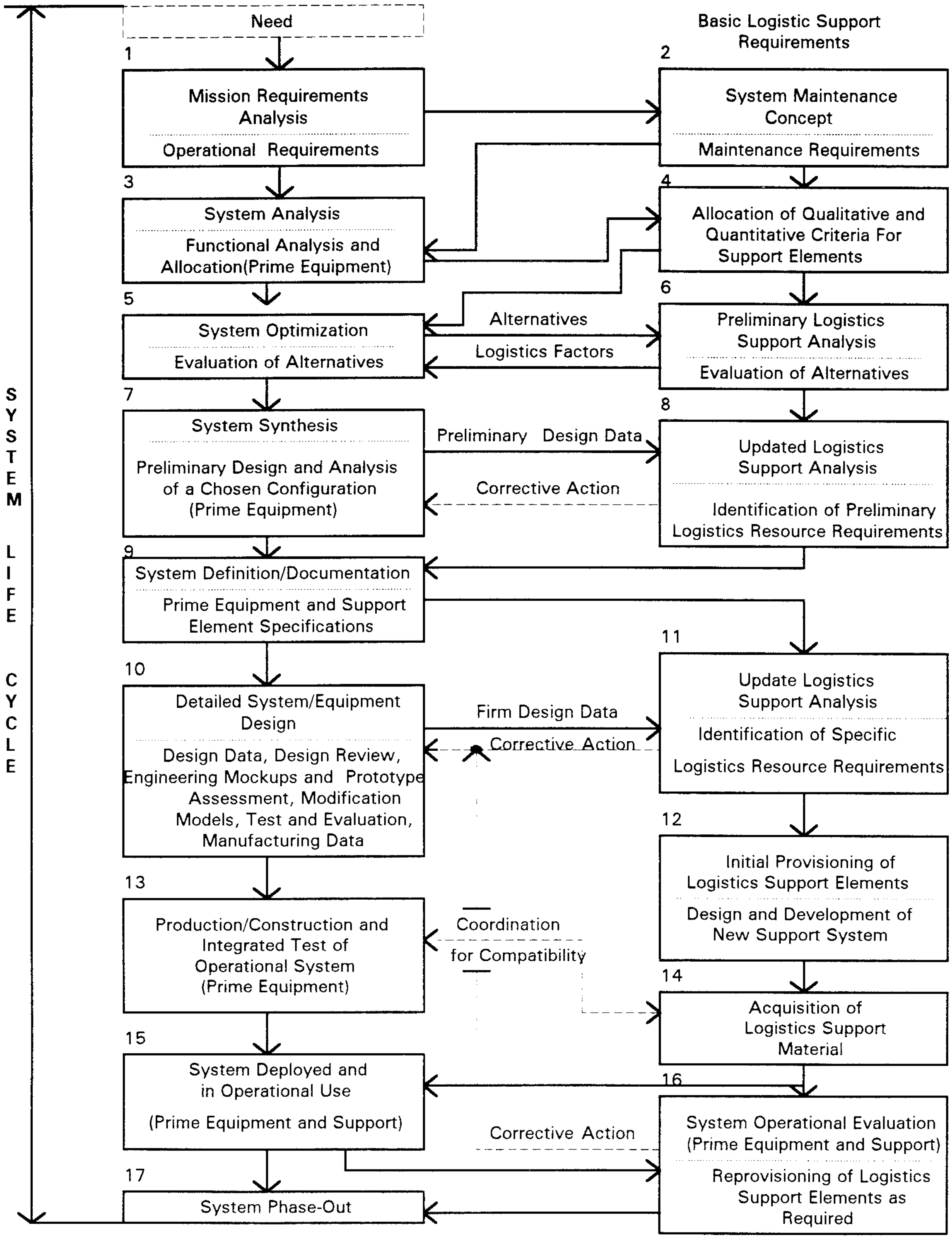

Figure 5. Life-Cycle Process [Ref. 2: p. 97]

As this cooperation effort progressed, the Joint Service LSA Technical Working Group (JSLSA-TWG) evolved. The JSLSA-TWG consisted of technical and functional representatives involved in application of the LSA process from all the DoD Services. The efforts of this group revealed recurring problems during implementation of LSA and LSAR. It was concluded that a total rewrite of MIL-STD-1388-1 and development of a Joint Service LSAR Automated Data Processing (JSLSAR-ADP) software, which included revision of MIL-STD-1388-2, was necessary.

In September 1980, the DoD LSA Steering Group (LSA-SG) was formed to oversee the revision efforts. The LSA-SG was composed of senior executive service-level representatives from all DoD services. The LSA-SG sponsored the formation of a DoD LSA Support Activity to perform the revision efforts. The DoD LSA Support Activity mission was eventually assigned to the United States Army Material Command (USAMC) Material Readiness Support Activity (MRSA) in November 1981.

In April 1983, the new standard on LSA, now designated MIL-STD-1388-1A, was released. In order to remain consistent with other DoD acquisition policies, plans, and directives, Notice 1 to MIL-STD-1388-1A was released in February 1988.

In July 1984, the new standard on LSAR, now designated MIL-STD-1388-2A, was released. The supporting JSLSAR-ADP software was released in October 1984. The evolutionary nature of the LSA process has resulted in Notice 1 (February 1986) and Notice 2 (January 1987) to MIL-STD-1388-2A, along with new releases of the JSLSAR-ADP software.

By 1987, program and logistics managers had available both the authority and technical capability to methodically and actually influence the design of weapon systems under development. The need to satisfy a wider range of logistics data and product requirements along with the advent of CALS objectives has sparked the revision of MIL-STD-1388-2A (designated MIL-STD-1388-2B) and the JSLSAR-ADP software (designated the Joint Service Relational LSAR(JSR-LSAR) software). The revision has given DoD the opportunity to apply computer technology in a more efficient manner by utilization of RDBMS technology in the LSAR. This represents a radical departure from current batch processing JSLSAR-ADP software, and will provide greatly enhanced capability for users to link with

and store data for numerous logistics and engineering functions. The MIL-STD-1388-2B will reflect a CALS philosophy by doing away with the LSAR data records currently in appendix A of MIL-STD-1388-2A and by replacing the sequential flat file format for the LSAR master files currently in appendix C of MIL-STD-1388-2A with LSAR relational tables. [Ref. 8:p. 19]

D. SUMMARY

After the occurrence of ILS, there was a great enhancement in U.S. Department of Defense Logistics areas; but as with the rapid development of computer technology and the establishment of system engineering theory, its concept is continuously changing. Through the implementation of ILS, the U.S. Government found some problems such as increased paper work, data duplication and inaccuracy, time consuming maintenance, and expense. Many of these problems can't be resolved through information technology as employed by the CALS initiative. It may be said that ILS and CALS now share the common objectives and are inseparable. There are many similarities in ILS and CALS. The next chapter illustrates CALS, a concept designed to improve ILS through integrated automation [Ref. 9:p. 1].

III. COMPUTER-AIDED ACQUISITION AND LOGISTICS SUPPORT (CALS)

A. BACKGROUND

1. Definitions and Objectives

Computer-aided Acquisition and Logistics Support (CALS) is an initiative to enable and accelerate the integration of digital information for major system acquisition, design, manufacture and support. The CALS initiative will provide for an effective transition from current paper-intensive life cycle processes to the efficient use of digital information technology. The overall objectives of CALS are to dramatically reduce product development lead times, improve quality, and reduce acquisition and engineering costs by re-engineering acquisition and logistics business processes through the efficient application of computer technology [Ref. 8:p. 18]. In other words the purpose of CALS is to improve industry and DoD productivity and quality, and thus improve supportability, military readiness, and combat effectiveness. From the MIL-HDBK-59A the objectives of CALS are:

(1) to accelerate the integration of design tools such as those for reliability and maintainability into contractor Computer-Aided Design(CAD) and engineering systems as part of a systematic approach that simultaneously addresses the product and its life-cycle manufacturing and support requirements;

(2) to encourage the reduction and eventual elimination of duplication of data, and to accelerate the automation and integration of contractor processes for generating weapon system technical data in digital form; and

(3) to rapidly increase DoD's capabilities to receive, store, distribute, and use weapon system technical data in digital form to improve life-cycle maintenance, training, and spare parts reprocurement, and other support processes. [Ref. 10:p. iv]

Achieving these objectives will lead to improved national and international competitiveness.

2. Policy Direction

In 1982, Secretary of Defense asked for the research for the reduction of Operation and Management cost and Military Budget spending. In September 1985, Deputy Secretary of Defense William H. Taft IV issued a memorandum outlining a strategy for transitioning from the current paper-intensive weapons system support process to a largely automated and integrated mode of operation.

The stated goals are to have the DoD establish plans to acquire, process and use logistics technical information in digital form for all new weapons systems entering production in 1990 and beyond. In March 1986, CALS stood for Computer Aided Logistics Support. By 1987 this had become Computer-aided Acquisition and Logistics Support to reflect the addition of acquisition while retaining the same acronym. On August 5, 1988, Deputy Secretary of Defense Taft issued a letter that became the "main driver for CALS" to the service secretaries. It directed that systems entering development after September 1988 would require proposals for integration of contractor systems and processes, specified government access to contractor-maintained data, and delivery and use of data in standard digital format [Ref. 11:p. 38]. At the end of 1989, although Reliability and Maintainability (R&M) had been taken into account from the early stages, it had become apparent that concurrent engineering was achieving greater importance with the result that there was a talk of CALS/CE [Ref. 12:p. 3].

B. OVERVIEW OF CALS

1. CALS Overview

CALS is a DoD and industry initiative to facilitate the integration of digital technical information for weapon system acquisition, design, manufacture, and support functions. In September 1985, CALS Steering Group was established to oversee its implementation. CALS is intended to improve schedule, cost and quality throughout the weapon system acquisition process through the creation and

use of a shared data environment, elimination of the development of duplicate data used for separate processes, and improved design and manufacturing capability where design changes will be linked to computer-aided design and engineering processes. Other improvements to be gained from CALS include reduced downtime through the use of automated diagnostics and feedback, improved responsiveness to industrial initiatives through the development of integrated design and manufacturing capabilities, reduction and eventual elimination of the costly paper environment, and improved reliability, maintainability, and combat effectiveness through the integration of automation technology [Ref. 10:p. 51].

2. CALS Strategy

From an Introduction to CALS, Smith says that CALS is a strategy that facilitates the integration of digital technical information for weapon system acquisition, design, manufacture, and support processes. It addresses requirements for an orderly transition from a labor and paper intensive environment to the efficient use of digital technical information for all these processes. Both the DoD and industry are investing in automation of a variety of processes to achieve productivity and quality gains. Existing islands of automation within the DoD, between the DoD and industry, and within industry must be interfaced and integrated to reduce the amount of duplicate data, and to eliminate requirements for expensive hard copy output and reentry of data. To achieve CALS benefit, a phased approach to CALS has been developed by a team consisting of OSD, the services, the DLA, and industry. The main elements of the strategy relate to standards, technology and methodology development and demonstration, weapon system contracts and incentives, and DoD systems. Phase I is essentially the digitization of existing data, with emphasis on the elimination of paper, whereas phase II is the integration of logistics data [Ref. 12:p. 48]. CALS strategic plan targeted technical manuals, engineering drawings, and logistics support analysis automations.

3. CALS Concepts and Standards

One of the principal means of achieving CALS is through standards so there can be unambiguous communication. The need is seen to accelerate the development and testing of standards for digital data interchange and integrated data base access. DoD systems will meet CALS requirements by implementing CALS standards and integration requirements in infrastructure modernization programs. CALS is based on a system approach in order to achieve digital information exchange. This is shown in Figure 6 [Ref. 12:p. 22].

There are four key elements

(1) industrial systems (for design, manufacturing, and customer support),

(2) government systems (for acquisition and logistics support),

(3) interfaces between industry and government, and

(4) interfaces within industry among prime contractors, subcontractors, and vendors (suppliers of systems).

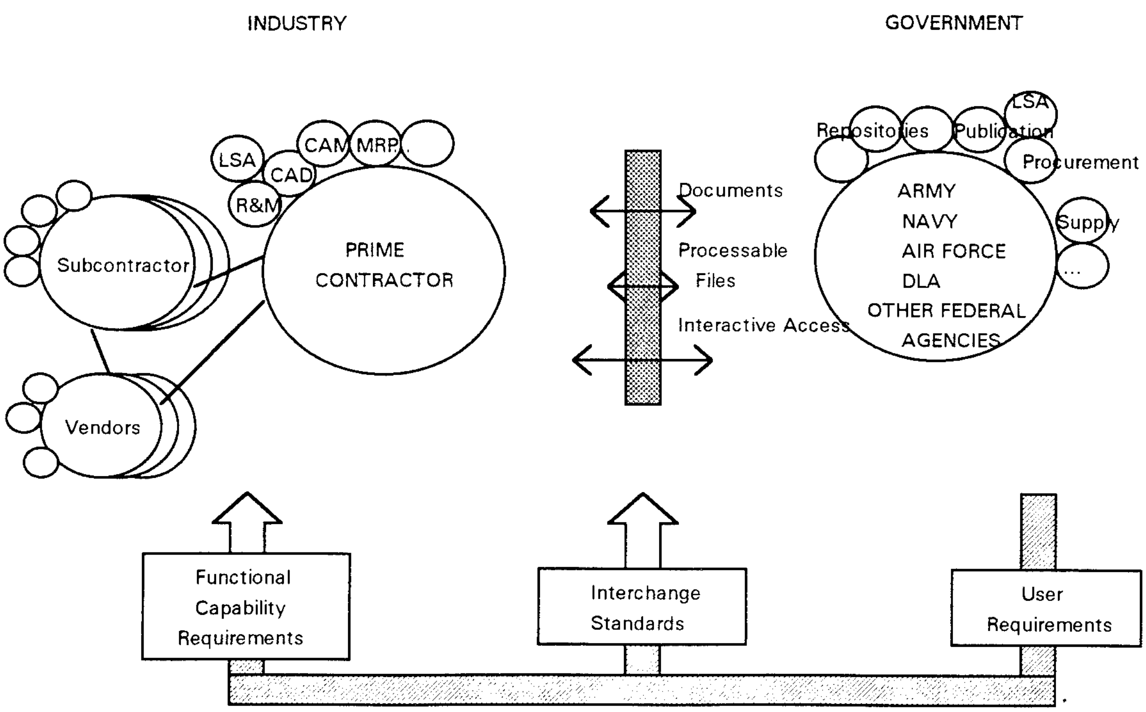

Figure 6. Digital Information Exchange [Ref. 12: p. 22]

Information can pass among these systems, in both directions, in the form of documents, processable data files, and interactive access to data bases. There are three broad groups of the CALS interchange:

(1) Functional requirements standards, consisting of military standards, military specifications, and Data Item Descriptions (DIDs) that define functional processes, data requirements, data creation procedures, and content and format of data products;
(2) Technical standards, consisting of federal standards, military standards, military specifications, and other relevant conventions, for the management, formatting, and physical media or telecommunications exchange of text, graphics, alphanumerics, and other forms of digital data; and
(3) Data management and access standards, the data dictionaries that provide rules governing data element definitions, data relationships, and requirements for data integrity and consistency, also standards for file structure definitions, index keys, and other descriptive information needed for access to data bases [Ref. 12:p. 23].

4. Concurrent Engineering (CE)

Concurrent Engineering is a systematic approach to create a product design that considers all elements of the product life cycle from conception through disposal. Concurrent Engineering is an integrated design approach that takes into account all desired downstream phases to produce a more robust design that is tolerant of manufacturing and uses variation, at less cost than sequential design. Concurrent Engineering is not the arbitrary elimination of a phase of the existing, sequential, feed-forward engineering process, but rather the co-design of all downstream processes toward a more all encompassing, cost effective optimum [Ref. 10:p. 56].

Concurrent Engineering is a team approach to creating a product design which considers all life cycle elements simultaneously. Contributing to the concurrent engineering strategy is the integration of R&M with CAD and CAE.

Integration of R&M with CAD and CAE is a high-leverage, high-payoff CALS target that will provide significant improvements in the inherent reliability and maintainability characteristics of a weapon system's design. Concurrent Engineering (CE) uses quality assurance to focus on user requirements and process improvements needed to meet these requirements. Greater operational effectiveness is expected to result, and a decrease in life cycle costs associated with the weapon system when deployed [Ref. 12:p. 24]. R&M integration with CAD/CAE will require changes to conventional post-design analysis processes. These includes the development of:

(1) user-friendly analytical tools to provide feedback about the effectiveness of the design approach while the design process itself is still taking place;
(2) effective means to take advantage of experience gained during design and field use in the form of design rules and expert systems; and
(3) fully characterized component design, performance, and reliability data in a format readily accessible by these automated tools.

To adopt concurrent engineering practice, it is necessary to get together key people responsible for the various processes in a multi-discipline team.

5. CALS Management Organization

There is a need to collaborate between DoD and industry for the successful planning, managing, and implementing CALS. To do this effectively, the two steering groups established a CALS management structure. The DoD CALS Steering Group has an initiative in formulation of CALS policy and implementation program. Under the authority of DoD Steering Group, OSD and CALS office provide the guidance for planning and implementation. Industry Steering Group provides the key point for CALS planning, technology and implementation concerns in the coordination of DoD Steering Group. Figure 7 shows the CALS management organization for DoD and Industry.

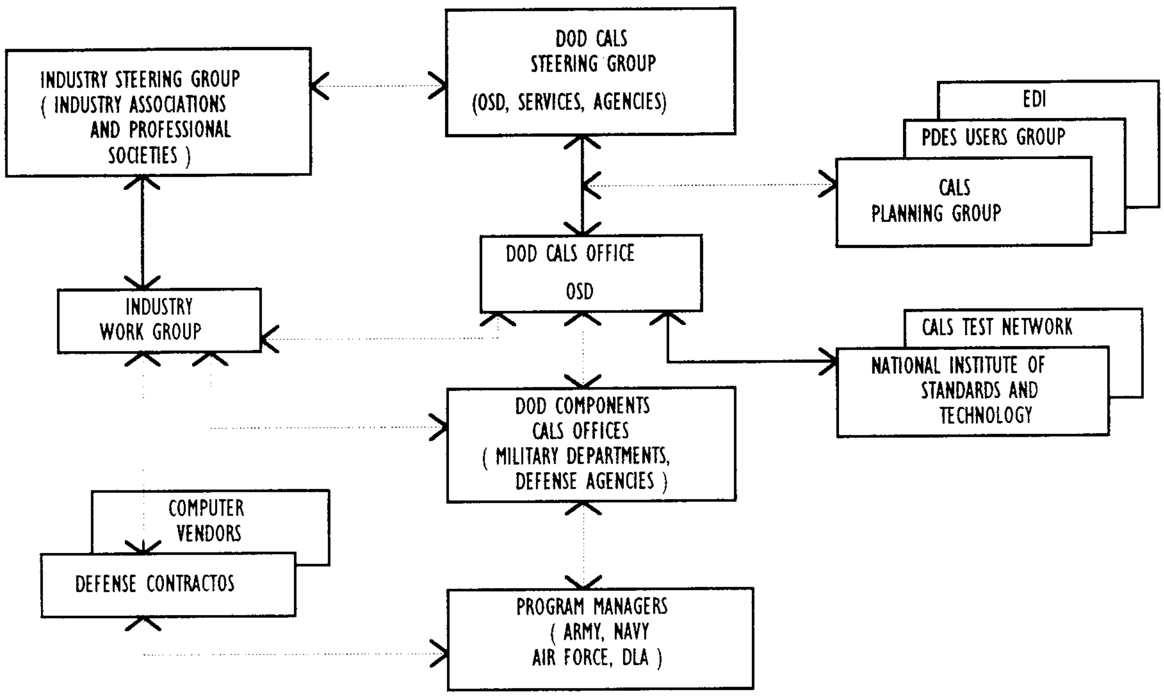

Figure 7. The CALS Management Structure [Ref. 12:p. 12]

6. CALS Architecture

DoD CALS Steering Group developed three major process architectures such as technical manual, engineering drawings, and logistics support analysis record. CALS architecture comes from the accomplishment of these three process architectures. In CALS architecture, ILS data is stored in the IWSDB with the development of Central Index. From user requirements to production, a new weapon system is developed by considering the elements of logistics support with the help of CAD, CAM, CAT, and CAE system. Real data is obtained from the field operation and can be continuously utilized in the process of weapon systems acquisition and logistics support. Figure 8 illustrates a concept of CALS architecture.

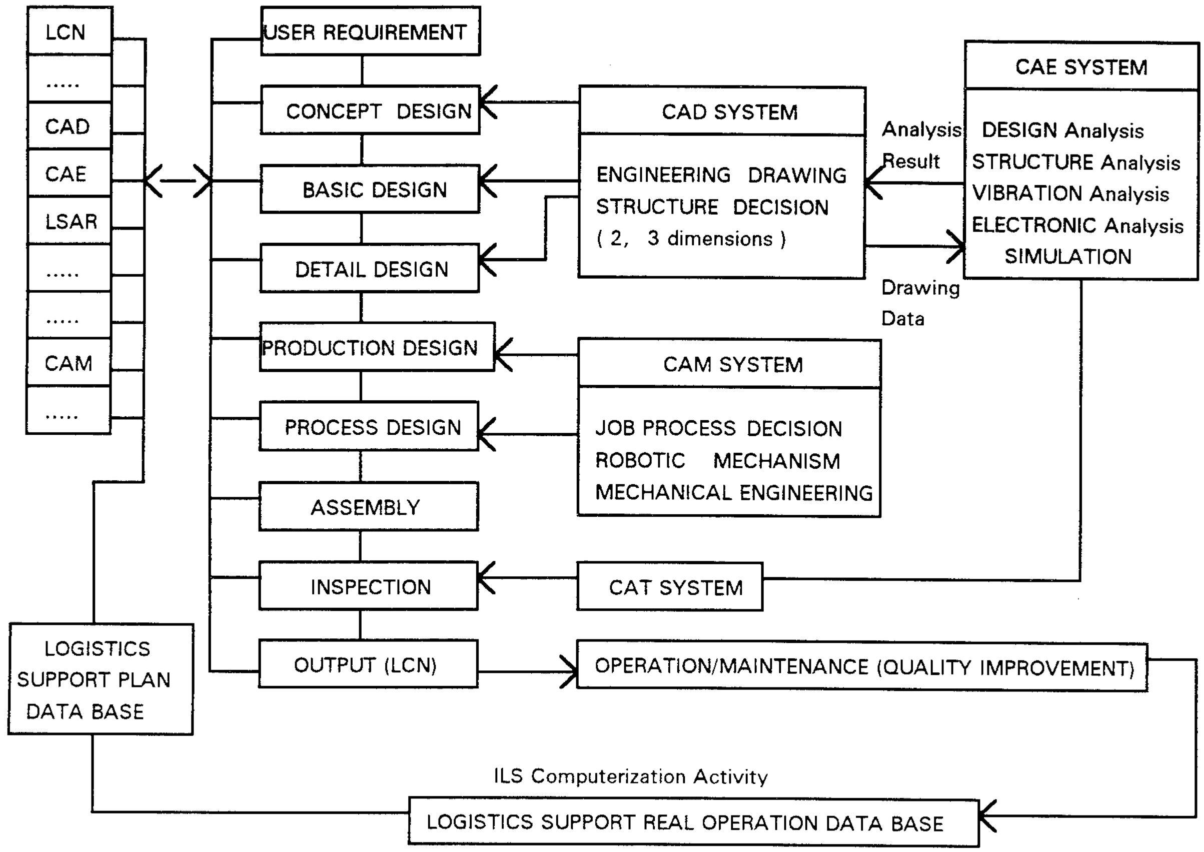

Figure 8. CALS Architecture

7. Standards and Specifications

A main CALS objective is to facilitate the transfer of information between industry and Government by integrating selected, existing international and national standards and accelerating the developing of new standards to support future requirements. CALS standards and specifications are established to obtain most effective and efficient data integration and interface. Because these standards and specifications are still revisioning, it is wise to keep up with new drafts and amendments as they are issued.

Standards are critical to an integrated environment for electronic data access and transfer. Testing of selected CALS standards is very important to verify that the digital exchange standards adequately support user requirements. Validation is to ensure that a selected standard meets the functional need. Conformance testing is implemented to ensure that the execution meets the selected standard. Acceptance testing is the process of ensuring whether the implementation meets the user's requirements.

For ensuring the levels of testing, several organizations are established. The National Institute of Standards and Technology (NIST) prepares product conformance testing procedures, the CALS Test Network (CTN) takes the responsibility for user application testing, and the CALS Digital Standards Office (CDSO) serves as technical agent for providing the life cycle support of the MIL-STD-1840 and MIL-28000 series Specifications. Table 2 [Ref. 14:p. 9] illustrates the CALS Standards and Specifications.

8. CALS Implementation

In implementation of CALS, DoD set two phases of goals. The first is the near-term goals for CALS implementation that is the attainment of increased levels of interfaced, or integrated, functional capabilities, and specification of requirements for authorized government access to contractor technical data base or for delivery of technical data to the government in digital form. The second is the longer-term goals for CALS implementation which is the integration of DoD data bases to share common data in an Integrated Weapon System Data Base (IWSDB) structure that is implemented through Contractor Integrated Technical Information Services(CITIS). Data deliverables from, or government access to, specified segments of CITIS data will be explicitly required in future contracts, developed in accordance with CALS standards and procedures. The technology to accomplish this will be incrementally implemented as emerging technologies are developed and proven. [Ref. 10:p. v]

Policy guidance issued by the Deputy Secretary of Defense on August 5, 1988 requires acquisition managers to evaluate CALS capabilities in source selection decisions and to implement cost effective CALS requirements in contracts for weapon systems and related major equipment items. Expanding

global markets and shrinking DoD markets have reduced the need for new weapon systems and required more modification and maintenance of existing weapon systems.

DOD	INDUSTRY	APPLICATIONS
MIL-HDBK-59		Provide guidance on the technology, standards, and procurement process as related to the transition from a paper intensive activity to one operating with digital information.
MIL-STD-1840		The primary defense standardization document for the selected CALS standards identifies, by application, which industry standard and corresponding DoD standardization documentation to use. It also provides standard "enveloping" procedures for transferring standard data forms.
MIL-D-28000	IGES	Initial Graphics Exchange Specifications (IGES) - A neutral file format for the representation and transfer of product definition data among CAD/CAM systems and application programs.
MIL-M-28001	SGML	Standard Generalized Markup Language (SGML) - Markup requirements, tagging and generic style specifications for page-oriened document text.
MIL-R-28002	CCITT GROUP 4	The efficient compression of scanned raster images. Uses the code from the Group 4 facimile recommendation of the International Telegraph and Telephone Consultative Committee (CCITT). A "tiled" form is described by using the architecture nomenclature of International Standard, IS 8613.
MIL-D-28003	CGM	Computer Graphics Metafile (CGM) - A neutral format for the description, storage and communication of graphical information.
EC/EDI	EC/EDI	Electronic Commerce/Electronic Data Interchange (EC/EDI) - The electronic interchange of business informaton between trading partners. Uses standard formats currently defined by ANSI X12 in the U.S., EDIFACT in Europe, and AECMA 2000 for NATO.
STEP	STEP	Standard for the Exchange of Product Model Data (STEP) - A computer interpretable data representation format being developed to include all product model data necessary to define geometry, function and behavior of a product throughout its life cycle. Product Data Exchange using STEP (PDES) is the U.S. standard activity supporting STEP.
MIL-STD-974	CITIS	Contractor Integrated Technical Information Service (CITIS) - Contractor provided service for electronic access and/or delivery of contractually committed business and technical information on a need-to-know basis.
MIL-M-87268	IETM	Prescribes the requirements governing the creation of Interactive Electronic Technical manual (IETM) and the development of IETM presentation software applicable to a computer-controlled Electronic Display System (EDS).
MIL-D-87269	IETM	Prescribes the interchange format for delivery of an IETM database to the Government.
MIL-Q-87270	IETM	Prescribes the requirements for an IETM Contractor's Quality Assurance program.

Table 2. CALS Standards and Specifications [Ref. 14: p. 9]

Figure 9 [Ref. 12:p. 48] shows the transition from the current paper flows via a digital flow phase I to the concept of an integrated data base in phase II.

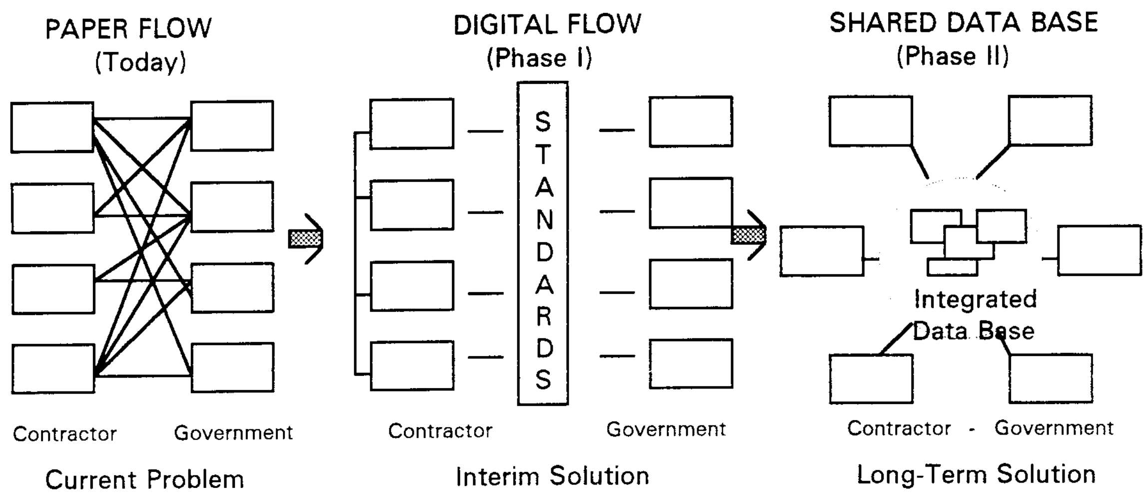

Figure 9. CALS Implementation Phases [Ref. 12: p. 48]

Initial (Phase I) implementation focuses on exploiting current and near term technology to enhance the highest impact acquisition and logistics functions which are:

(1) engineering drawings and other information used to support competitive spares procurement;

(2) technical manuals and other information used to support maintenance of weapon system;

(3) LSARs and other information used to plan logistics support; and

(4) automated technical interfaces among R&M data, logistics, system engineering, and CAD.

For the implementation of Phase I, two military standards have been added and four military specifications developed. Two military standards which were developed prior to the advent of CALS are:

(1) MIL-STD-1388-1 Logistics Support Analysis, and

(2) MIL-STD-1388-2 DoD Requirements for a Logistics Support Analysis Record.

The Military specifications are:

(1) MIL-D-28000 Digital Representation for Communication of Product Data: IGES Application Subsets,

(2) MIL-M-28001 Markup Requirements and Generic Style Specification for Electronic Printed Output and Exchange of Text,

(3) MIL-R-28002 Requirements for Raster Graphics Representation in Binary Format, and

(4) MIL-D-28003 Digital Representation for Communication of Illustration Data : CGM Application Profile.

All these standards and specifications are included in MIL-STD-1840A Automated Interchange of Technical Information (AITI). MIL-STD-1840A is the data exchange standard that provides the enveloping mechanism to structure files into documents and defines their organization and physical media format for delivery.

In Phase II the data formats will be redesigned to integrate the various collections of data. A Contractor Integrated Technical Information Service (CITIS) is required for a single weapon system to integrate all technical data. The purpose of CITIS is to retrieve, maintain, and provide access to technical and support information on a weapon system.

Services provided by the CITIS will also include accessibility to the information on a need-to-know basis. The CITIS will serve the acquisition manager, the weapon system contractor, the logistics manager, and life cycle support manager requiring technical data in their respective areas of responsibility. The CITIS is a collection of ADP systems and applications used by government agencies and offices to enter, manage, retrieve, and distribute technical data from a specific integrated weapon system data base(IWSDB) [Ref.12:p.51]. IWSDB is the conceptual definition for and total collection of shared product definition, management, and support data throughout the life cycle of a specific weapon system by accessing the CITIS and government technical information systems. The management function, performing the needed control and coordination with and among the CITIS and government systems supporting a weapon system, will be

provided by the IWSDB. Ultimately, in Phase II, the distributed data base technology for IWSDB will enable an authorized user to access information regardless of geographical location and computer system configuration.

9. CALS Benefits

It can be asserted that CALS has done more boost to information technology and methodology than anything else in the last period. It can be said that automaton and integration bring about improved quality, timeliness, and reduced costs. CALS is promoted as bringing about improved combat readiness at less costs. This can come about through concurrent engineering practice and technical manuals in electrical form which reduces costs and times. From the implementation of CALS, there are a lot of benefits in various areas such as acquisition and support, technical manuals, data bases, and design.

a. Acquisition and Support

Quality improvements and reduction in costs of acquisition and support are expected in the mid-1990s. Acquisition and support costs can be reduced from the elimination of duplicative, manual, and paper-intensive processes. This is because the information is available in an integrated data base, with a concept of store-once-use-many-times. While procuring spares, if Computer-Integrated Manufacturing (CIM) is established, it is easy to get spare part, with a 50 percent expected reduction in administrative lead time. Through the achievement of long-term CALS objectives, there will be more complete integration of contractor design, manufacturing, and support data system.

b. Technical Manuals

More efficient delivery and preparation is expected with respect to technical manuals. Technical authors increasingly use word processors when writing documentation which can be used straight into the system. DoD mentioned that it will promote a reduction in paper deliverables in contracts, leading to a reduction in government expenditure for manual processes involving paper handling, placing reliance on electronic methods. Through automation, industry has already experienced typical savings of 20 to 30 percent in technical manual

authoring and update processes. Air Force estimates show potential savings of $135 million in distribution and maintenance costs for technical manuals through having paperless technical manual systems. Another gains are obtained from the Navy by using the Navy Automated Logistics Publishing System (ALPS) for automation manuals. Costs were cut by 70 percent and work time reduced by 80 percent in less than six months. Weight is an significant issue for the Navy. The Aegis cruiser Vincenners carrying 23.5 tons of technical manuals above the main deck. By automation, the ship would rise three inches in the water.

c. Data Bases

Facilitated data exchange and access as well as reduced duplication of effort come about through integration of existing stored technical data. Improved accuracy, timeliness, and accessibility of data are expected to result from the provision in CALS of interchange standards and procedures to enable digital file transfer without hard copy generation and repetitive manual entry of data. With on-line access to shared data bases, many steps in current government and industry processes can be eliminated entirely, with a substantial reduction in overheads. ILS program savings of 20 to 25 percent are projected by companies where stand-alone logistics data bases have been interfaced or integrated to eliminate duplication of information [Ref. 12:p. 30].

d. Design

Integration of R&M engineering as an on-line part of the CAD/CAE design processes eliminate the situation of not being able to alter the design to accommodate R&M considerations that have come to light before it is too late. The integration of R&M analysis with design is already helping the development of diagnostic tools that are leading to trouble-shooting accuracy improvements of up to 35 percent, with concomitant cost and readiness payoffs [Ref. 12:p. 30].

C. INTEGRATED WEAPON SYSTEM DATA BASE (IWSDB)

From Figure 9, current problems will be solved in shared data form within integrated database. The final goal for the CALS is the accomplishment of the Integrated Weapon System Data Base (IWSDB). Figure 10 [Ref. 12:p 52] shows

the concept of IWSDB. There will be a vertical access to data base within a single weapon system, and horizontal access to data bases across different weapon systems. Product definition data could be included in the IWSDB, any digital drawings being contained in digital technical data packages that form part of a three-dimensional product data base structured in accordance with Product Data Exchange using STEP (PDES). In accordance with PDES, the use of engineering drawings are eliminated rather than implemented in digital form. IWSDB will contain very few drawings but will be able to supply more complete product definitions from which drawings may be generated if required [Ref. 12.p. 53].

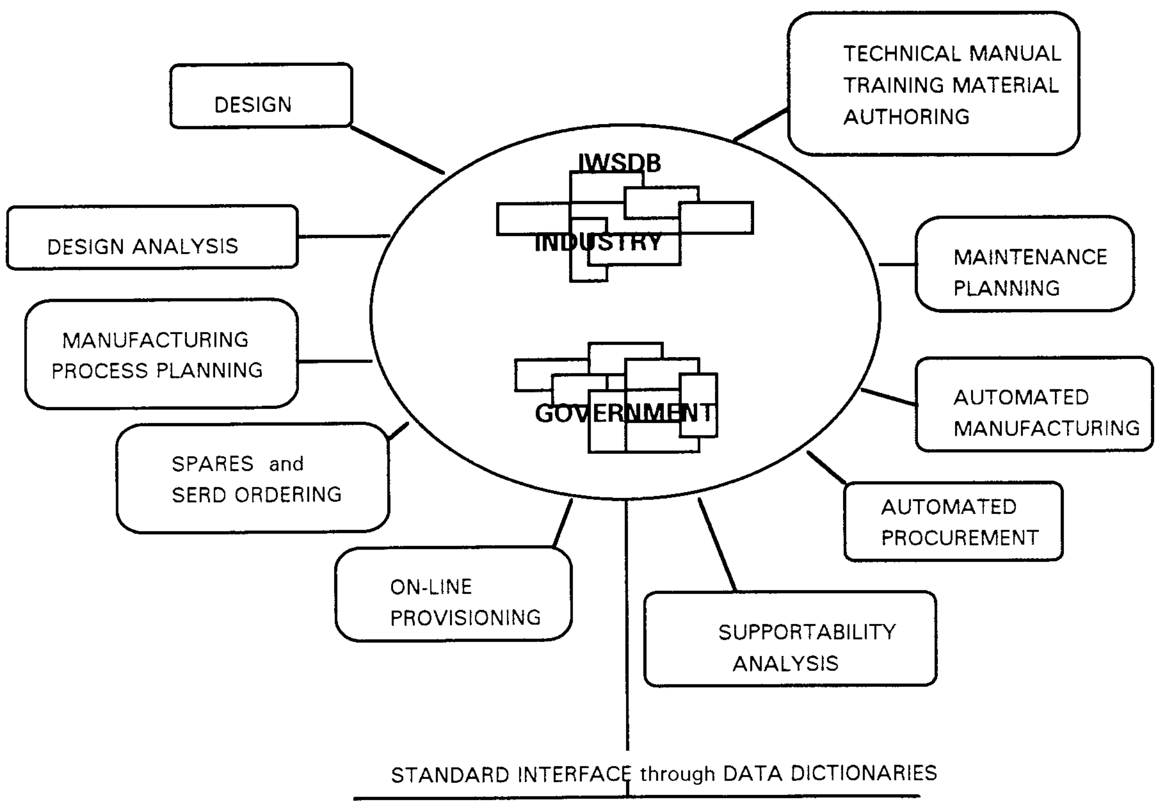

Figure 10. The IWSDB [Ref. 12: p. 52]

The IWSDB leads on-line review and approvals, and provisioning and ordering. On-line LSARs are connected to LSA data dictionary which is linked to the integrated data base dictionary. It provides real-time updates of data. The IWSDB will contain information relating to product design, engineering analysis, manufacturing, and support.

Also, various logistics data products, such as technical publications, drawings, and support plans will be developed to materialize IWSDB. Finally, the IWSDB will be controlled by a data dictionary, technical data sharing to be at a data base level, rather than at a physical file level, with multiple formats of the same data from a common configuration source available to different users. To do this, standard should be developed for data management and access.

Alternative technologies and methodologies are being evaluated as part of the Research and Development program before a commitment is made to the IWSDB in practice, with transition from separate systems and processes that are interfaced to those that are integrated [Ref. 12:p. 53]. The key development areas selected include CAD, CAE, and CIM, concurrent engineering and integration of R&M with design, electronic manual and delivery systems, and telecommunications access to parts data bases. All kinds of benefits will not be easily achieved until the end of the decade when phase II has been in operation for some years. But after the accomplishment of IWSDB, there are several benefits that can be defined. They are as follows:

(1) More complete integration than is possible within interfaced "stovepipe" systems of contractor design, manufacturing, and support data systems based on advanced product data models;

(2) Near real-time updates of technical data to match weapon system configuration;

(3) On-line access by authorized government users to distributed contractor and government data bases;

(4) Data bases owned by DoD, but possessed and maintained either by DoD or by contractors;

(5) Improved authoring and delivery of technical manual and training material;

(6) Reduced lead-time for acquisition of spare parts;

(7) Improved R&M characteristics as a result of R&M integration with CAD/CAE design processes; and

(8) Application of concurrent engineering strategies and programs to optimize product and acquisition process design and development.

IV. RELATIONSHIPS BETWEEN ILS AND CALS

In the Integrated Weapon Systems Data Base (IWSDB), one of the most critical factors is the accomplishment of Integrated Logistics Support (ILS). In the early 1970's, ILS was implemented by MIL-STD-1388-1 and MIL-STD-1388-2. The CALS concept was introduced simultaneously in the mid-1980's while MIL-STD-1388-1 and MIL-STD-1388-2 were being revised. The basic concepts underlying ILS and CALS are almost the same: to fully utilize all available resources and to reduce the life-cycle costs as much as possible.

In the ILS phase, every step was done through its own procedures without sharing data bases. Also the choices of media, storage, and maintenance procedures were not standardized nor unified. The prominent difference between the ILS and CALS concepts came during the revision of MIL-STD-1388-2A for the LSAR. A draft revision, MIL-STD-1388-2B, dated 31 March 1989, referred to a relational data base whereas MIL-STD-1388-2A was for flat files. The new standard added 83 new data elements to increase the utility.

Some of the major changes from MIL-STD-1388-2A are:

(1) Requirement for data to be delivered in relational table formats,

(2) Elimination of data input records and data elements associated with card formats, and

(3) Elimination of non-product oriented output summaries [Ref. 10:p. 110].

Table 3 illustrates the differences between MIL-STD-1388-2A and MIL-STD-1388-2B.

From these changes Integrated Logistics Support (ILS) can interface with Integrated Weapon Systems Data Base (IWSDB). The goals of the ILS were to support influence design, develop resource requirements, acquire resources, and provide support at a minimum cost. The CALS objectives are to reduce time to market through the use of integrated data, improve quality by linking databases, and reduce acquisition and engineering costs by elimination of duplication of data used for separate process design, manufacturing and support.

	DIFFERENCES
MIL-STD-1388-2A	. Batch File Process (Card Input) . A lot of Data Duplications . 14 kinds of Input Method . 59 kinds of Output . 11 digit LCN ---- Difficulties in Complex Systems Analysis
MIL-STD-1388-2B	. Relational Data Base - Reduction in Data Duplication - Increase in Access Supportability - Maintainability Enhancement . 104 Relational DataBase (10 Functional Area) . 48 kinds of Output . 18 digit LCN ---- Possible to Assign Functional/Physical LCN . CALS Standard LSAR System

Table 3. The Differences between MIL-STD-1388-2A and 2B
Source: CALS/ILS Pamphlet

To achieve these goals both ILS and CALS developed their own elements for implementation. The principal elements of ILS are maintenance planning, reliability and maintainability, technical data, personnel and training, facilities, support and test equipment, supply support, packaging, transportation and handling, logistics support resource funds, and logistics management information.

In CALS, goals can be obtained from the accomplishment of Phase II (Shared Data Base). Therefore the major issue for the long-term objective of CALS is the perfect implementation of the Integrated Weapon Systems Data Base (IWSDB). The elements of the IWSDB are technical manual and training material authoring, maintenance planning, automated manufacturing, automated procurement, supportability analysis, on-line provisioning, spares and SERD ordering, manufacturing process planning, and design and design analysis. From the elements of ILS and IWSDB it is easy to find their similarities.

CALS will use three data bases: the product definition data base, which includes engineering drawings, design criteria, and additional production definition; the technical support data base, which is composed of technical orders, operational manuals, and training courses; and the logistics support data base

which consists of support equipment definition, facilities and manpower, and provisioning [Ref. 16:p. 39].

Figure 11 displays the relationship between the ILS and the IWSDB.

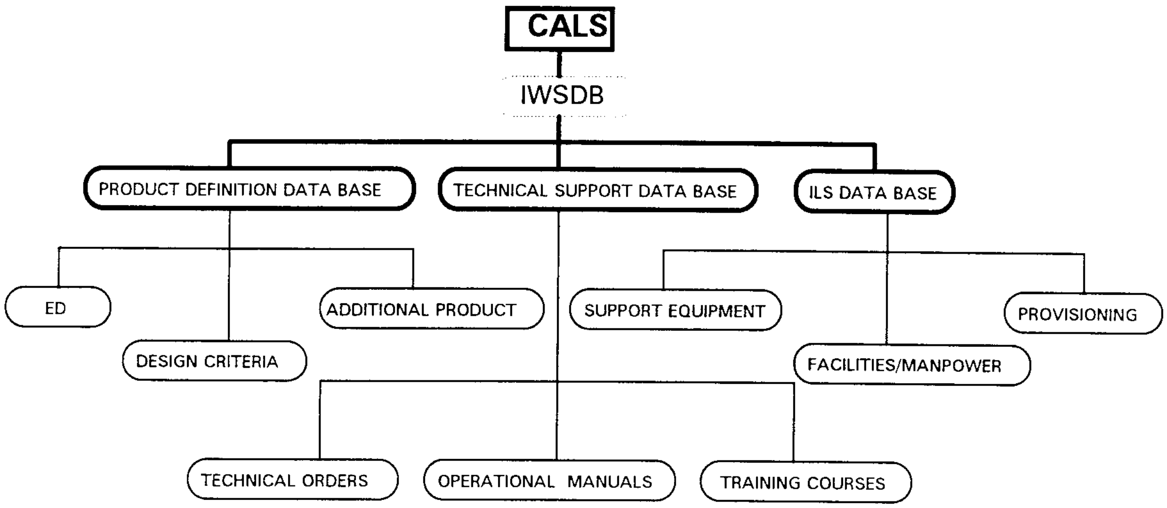

Figure 11. Relationship between ILS and CALS [modified Ref. 16:p. 39]

The final general area of automation that CALS will provide is the distribution and usage of logistics products. CALS focuses on how to use technology to make ILS more effective and productive. CALS will try to give both the design engineer and R&M engineer interactive access to the same data base. On-line real time information exchange will make the system more reliable and supportable. The integrated data base will include not only CAD, CAE, and CAM data, but also complete product and process descriptions along with logistics design criteria.

It is obvious that there still is a big argument in CALS implementation. Each service has complained about the cost, time, and difficulty of implementing CALS. Further, there is concern that the DoD standards are too general and need to be modified for each service. Therefore, for effective implementation, although DoD-wide consistency is necessary, flexibility to adapt to the needs of each

service is also necessary. Effective CALS implementation can ensure that the future weapon systems and logistics support systems produced will be more reliable and stable. Even lower level technicians will be able to access real-time data at the location where they are performing maintenance in the CALS environment.

V. CONCLUSIONS

A. CONSIDERATIONS FOR LOGISTICS IN SOUTH KOREA

The structure of the Korean Armed Forces (KAF) is very similar to the structure of the United States Armed Forces. However, the operational area of the Korean Armed Forces (KAF) is limited to the Korean Peninsula. Also KAF has weak background in computer technology, software development, defense industry, and budget constraints. To overcome these vulnerabilities KAF should consider the following observations for successful implementation of ILS and CALS:

1. Continuous Consideration of World Trends in Logistics Support

It is essential to concentrate on future logistics trends for successful weapons systems acquisition and logistics support. New computer technology is endlessly being introduced and CALS policy and standards are continuously changing. As a first step, it is important to follow international standards to reduce confusion. Secondly, it is necessary to develop MND's own standards which fit its own environment.

2. Set Up Level for Full Implementation

The U.S. identified three phases for full CALS implementation. Full CALS implementation will be achieved by the year 2010. The MND of Korea must establish phases for successful CALS implementation.

> ***(1) Establish a CALS Department in the Ministry of National Defense of Korea.*** CALS is the major issue in logistics today. There is a need to build a CALS department to organize, control, and supervise the whole process for effective and efficient achievement of CALS objectives. This department must take the initiative in policy determination, standardization, and budget acquisition and spending. Also this department should be

expanded to the lower levels such as each Armed Forces Headquarters, Logistics Headquarters, and so on.

(2) ***Develop Standards for the Connection of Existing Computer Networks.*** Complete CALS implementation will require large investments for the technology to interconnect the existing system and new computer systems. It is important to analyze the current system's limitations and weak points. Not only the Ministry of National Defense of Korea (MND) but also civilian industry has a low level of computer technology and economic resources compared to those of the U.S. South Korea faces risks in the execution of a new concept. To minimize these risks, South Korea should adopt international standards in the first stage, accumulate experience, and finally develop its own standards.

(3) ***Select Demonstration Program for Key Weapons Systems.*** It would be difficult to convert all historical data to CALS at the same time. CALS can be developed through a demonstration program. It is essential to develop the key CALS process architectures which are Technical Manual (TM), Engineering Drawing (ED), and Logistics Support Analysis Record (LSAR) in a demonstration program. From this demonstration program MND can reduce time and cost, and accumulate CALS experience.

3. Adequate Data Protection and Integrity Policy

Data protection and integrity are key factors for successful national security. Data protection is necessary to protect data from unauthorized use and dissemination. It should ensure the integrity and confidentiality of all CALS assets. Under the control of MND, the Institute for Defense Information Systems (IDIS) of South Korea should be responsible for setting data security policy and monitoring data integrity.

B. CONCLUSIONS

The U.S. DoD found several problems in current logistics support such as excess paper work, duplication of data, and unjustified expense. Technological advances have made it possible for DoD to cure those problems. DoD believes that CALS will alleviate the inaccurate and incomplete reprocurement of technical data packages for spares' replenishment, difficulties in out-dated technical manuals' maintenance, trouble in the control of engineering drawings, and inadequate documentation and maintenance of configuration management.

CALS will lead both the civil and defense industries into the future. To keep pace with international trends in military technology and industrial practice, CALS should be implemented as soon as possible. The elements of ILS must be focused on the view point of CALS. Establishment of IWSDB is the key success factor in connecting ILS and CALS. The Ministry of National Defense of Korea is trying to realize the benefits of ILS and CALS. The MND has given highest priority to CALS in an attempt to reduce response time, increase customer service, and eliminate cost burden for the future defense and industry environment. There are yet significant obstacles to overcome for successful CALS implementation in South Korea. The obstacles include the low level of current computer technology in MND, the difficulty of applying CALS to small business organizations prevalent in the Korean economy, and a lack of consensus at the higher administrative levels on how to implement CALS. To overcome these obstacles, the MND can purchase computer technology; allow small business time to adapt to CALS and can provide assistance in the process; and should quickly establish a consistent policy for CALS implementation. The Ministry of National Defense of South Korea should develop its own CALS structure while maintaining world CALS standards.

LIST OF REFERENCES

1. U.S. Department of Defense Directive 4100.35, Development of Integrated Logistics Support for Systems & Equipment, 19 June 1964.
2. Blanchard, B. S., Logistics Engineering and Management 4th edition, Prentice-Hall, Inc., 1992
3. James V. Jones, "Integrated Logistics Support Handbook," 1987
4. Mary Kay Allen, "Integrated Logistics Support Elements," Logistics Spectrum, Winter 1986
5. U.S. DoD directive 4100.35G, "Integrated Logistics Support Planning Guide for DoD systems and equipment," October 1968
6. Richard L. Nidever., "ILS and design influence," Logistics Spectrum, Winter 1987
7. ROK MND , Defense White Paper, 1991~1993
8. Jim W. Crabtree, Ellis O. Atkinson, "Logistics Support Analysis," Logistics Spectrum, Fall 1989
9. Scott A. Wagoner, Ph.D, "Logistics and Quality Management," Logistics Spectrum, Winter 1989
10. DoD, "MIL-HDBK-59A, CALS Program Implementation Guide," September 1990
11. Rowland G. Freeman III, "International CALS - International Future," Logistics Spectrum, Winter 1991
12. Joan M. Smith, "An Introduction to CALS : The Strategy and the Standards," May 1990
13. ARC Professional Services Group, "Presentation to the R.O.K Ministry of National Defense," July 1992
14. CALS Reference Guide, "CALS Standards," April 1994
15. DoD, "MIL-STD-1840A, Automated Interchange of Technical Information," December 1987
16. Robert G. Stein, " Futuristic Logistics : Will Congress See ALS in CALS," Spring 1986

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